

“Cable Tray #2”

Zinc Whiskers Detected on Zinc-Coated Steel Cable Tray

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Analyses by: Lyudmyla Panashchenko/NASA Goddard

Executive Summary

- “***Cable Tray #2***” was examined at NASA Goddard Space Flight Center (GSFC) to determine if zinc whiskers are growing out of the zinc-coated iron-based wire used in its construction
- Methods of analysis included:
 - X-Ray Fluorescence (XRF) Spectroscopy
 - Determine composition of surface finish on cable tray from which whiskers are growing
 - Energy Dispersive X-ray Spectroscopy (EDS)
 - Determine composition of the metal whisker
 - Optical Microscopy - 1x to ~100x
 - Document filament/whisker shapes and dimensions
 - Scanning Electron Microscopy (SEM) - ~50x to 5000x
 - Document filament/whisker shapes and dimensions
- ***CONFIRMED: Zinc whiskers are growing from this cable tray***
 - Dimensions (i.e., lengths and thicknesses) and morphology of growths are consistent with zinc whiskers.
Whiskers in excess of 0.5 mm in length were observed
 - Composition analysis confirmed both the metal whiskers & surface finish are ZINC

Background

Contained herein is analysis performed on “Cable Tray #2” of 2 samples

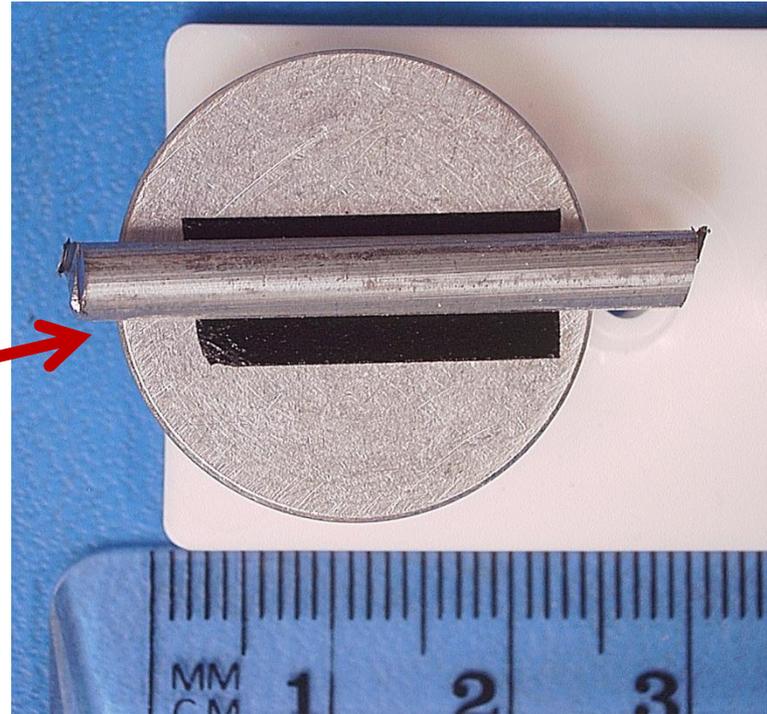
- Two distinctly different cable tray samples were provided by G. Camburn to J. Brusse in September 2012
 - Hereafter referred to as “Cable Tray #1” and “Cable Tray #2”
 - Based on naked eye inspection G. Camburn suspected each cable tray may exhibit zinc whisker growth, but he lacked access to analysis tools for confirmation
 - G. Camburn reports that each cable tray is made from “pre-galvanized” iron where a zinc coating has been applied to the iron-based wire by immersing the wire into molten zinc
 - G. Camburn suggests the following reference is representative of process used in making the wire:
<http://www.youtube.com/watch?v=J3aLT2B2m3Y>
- J. Brusse agreed to have the cable trays inspected to confirm and document any metal whiskers
- L. Panashchenko performed optical microscopy, scanning electron microscopy (SEM) and X-ray fluorescence (XRF) spectroscopy to confirm that this cable tray has developed zinc whisker growths

Cable Tray #2

Cable Tray #2 “As-Shipped”



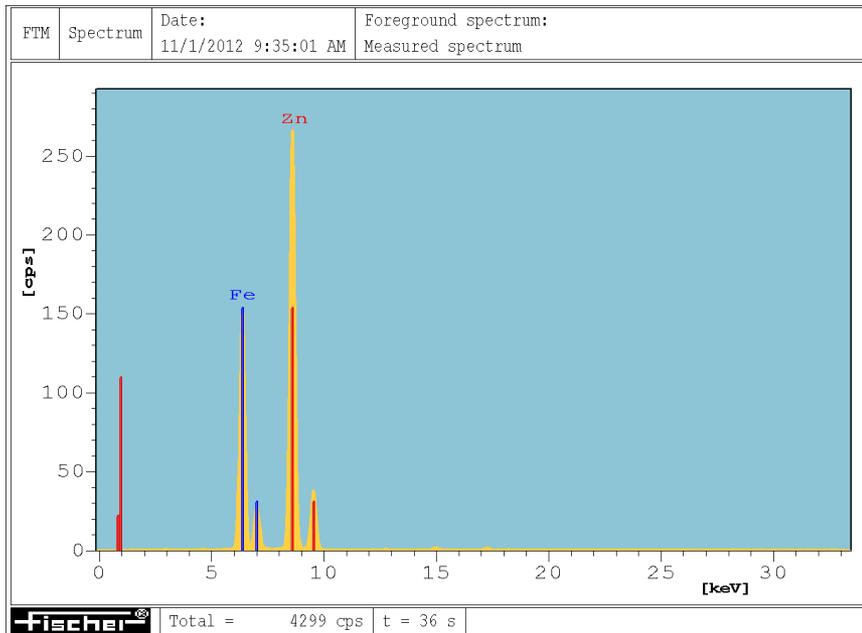
Piece of Cable Tray #2 Removed by J. Brusse for Detailed Analyses Documented Herein



X-ray Fluorescence (XRF) Spectroscopy Confirms Cable Tray #2 is Zinc-Coated Iron Alloy Wire

**XRF Results Confirm Cable Tray #2 is Made of
Zn-Coated Iron Alloy Wire**

Zinc Coating ~12 microns Thick



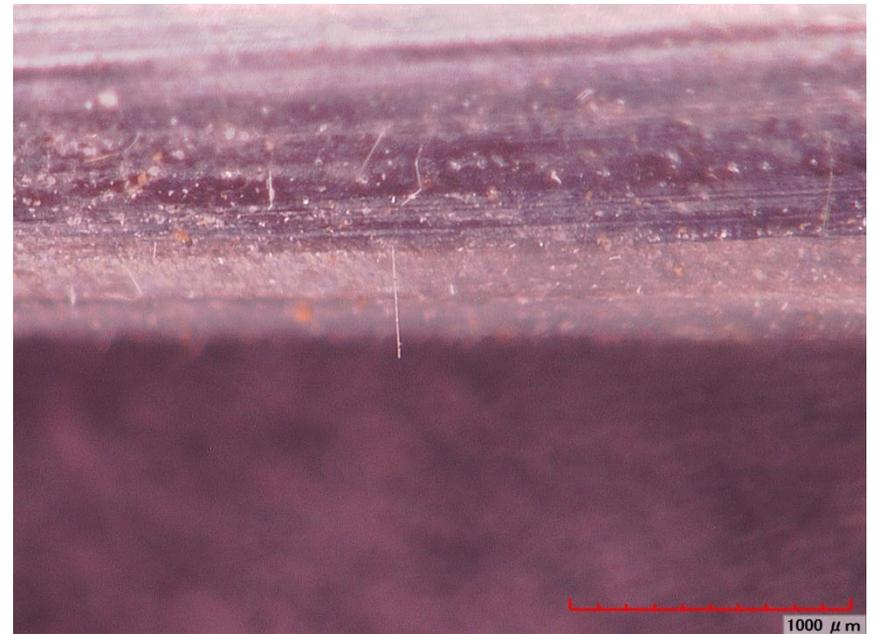
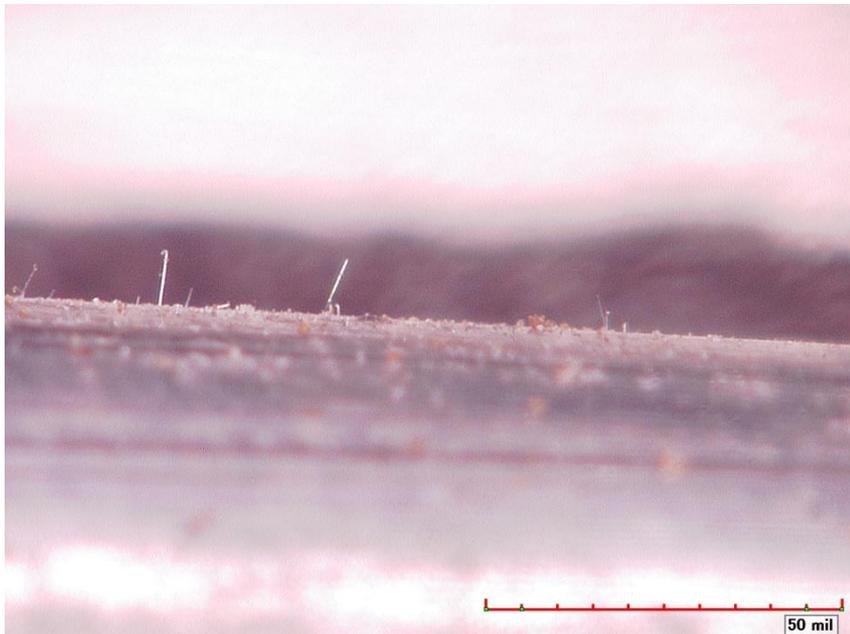
Meas. para. (foreground spectrum):
 High voltage = 50 kV (875) Prim. Filter = Ni10
 Collimator 2 = 0.30 Dm. Anode current 1000 uA
 Meas. distance = 0.001 inch

List of spectra:
 Foreground: Measured spectrum

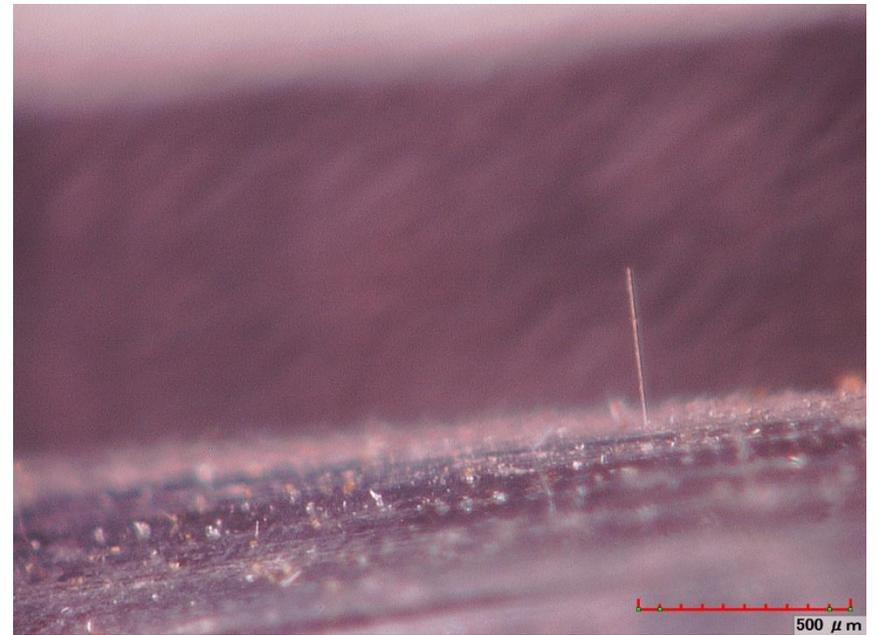
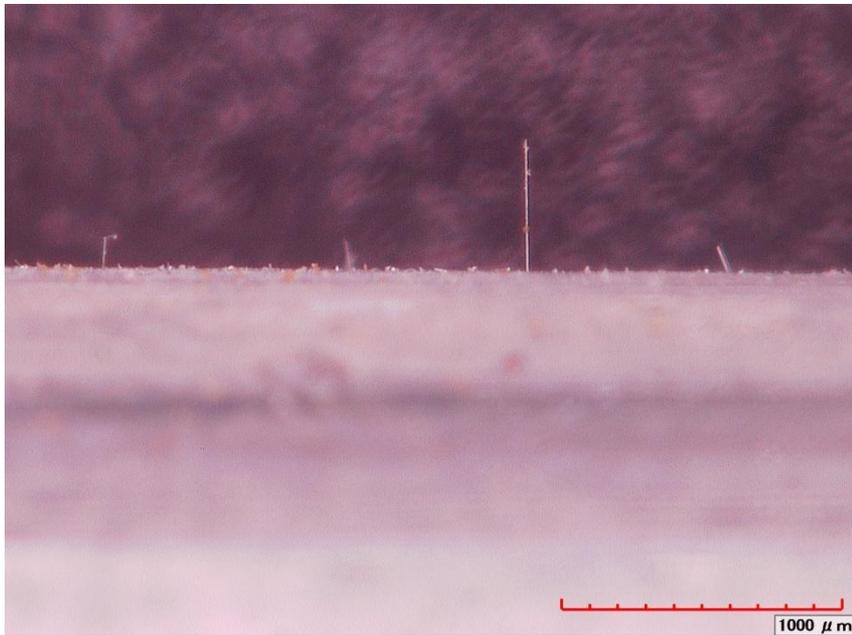
No	Zn 1 [μm]
Block 1	
1	14.6
2	10.1

*Side note: the base metal here is referred to as iron, but other variations, such as steel, are likely.
 XRF is not able to detect carbon which would further identify the material as steel*

Optical Microscopy Identifies Filamentary Growths on Cable Tray Surface

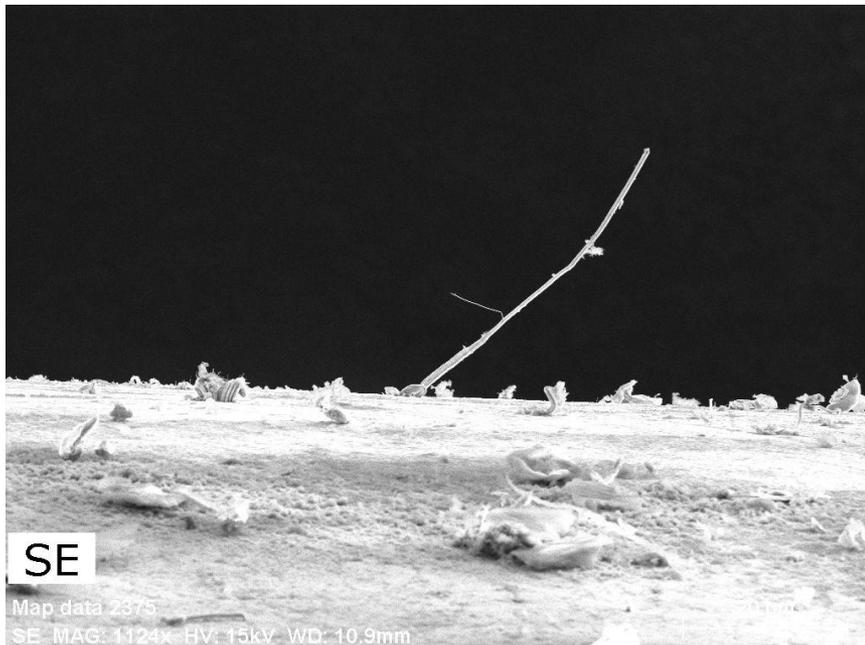


Optical Microscopy Identifies Filamentary Growths on Cable Tray Surface



Composition Analysis of Whisker Using Energy Dispersive X-ray Spectroscopy (EDS) Shows the Whiskers and Surface Finish are ZINC

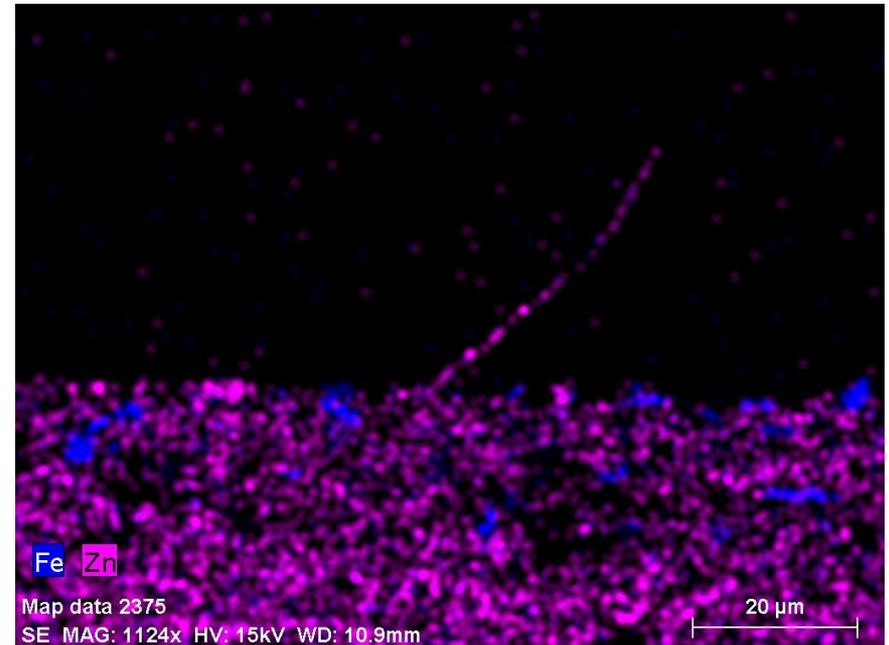
SEM Image of a Metal Whisker on Cable Tray #2



ThinTray-Sample2_02_SE

EDS image showing Whisker and Surface Finish are ZINC

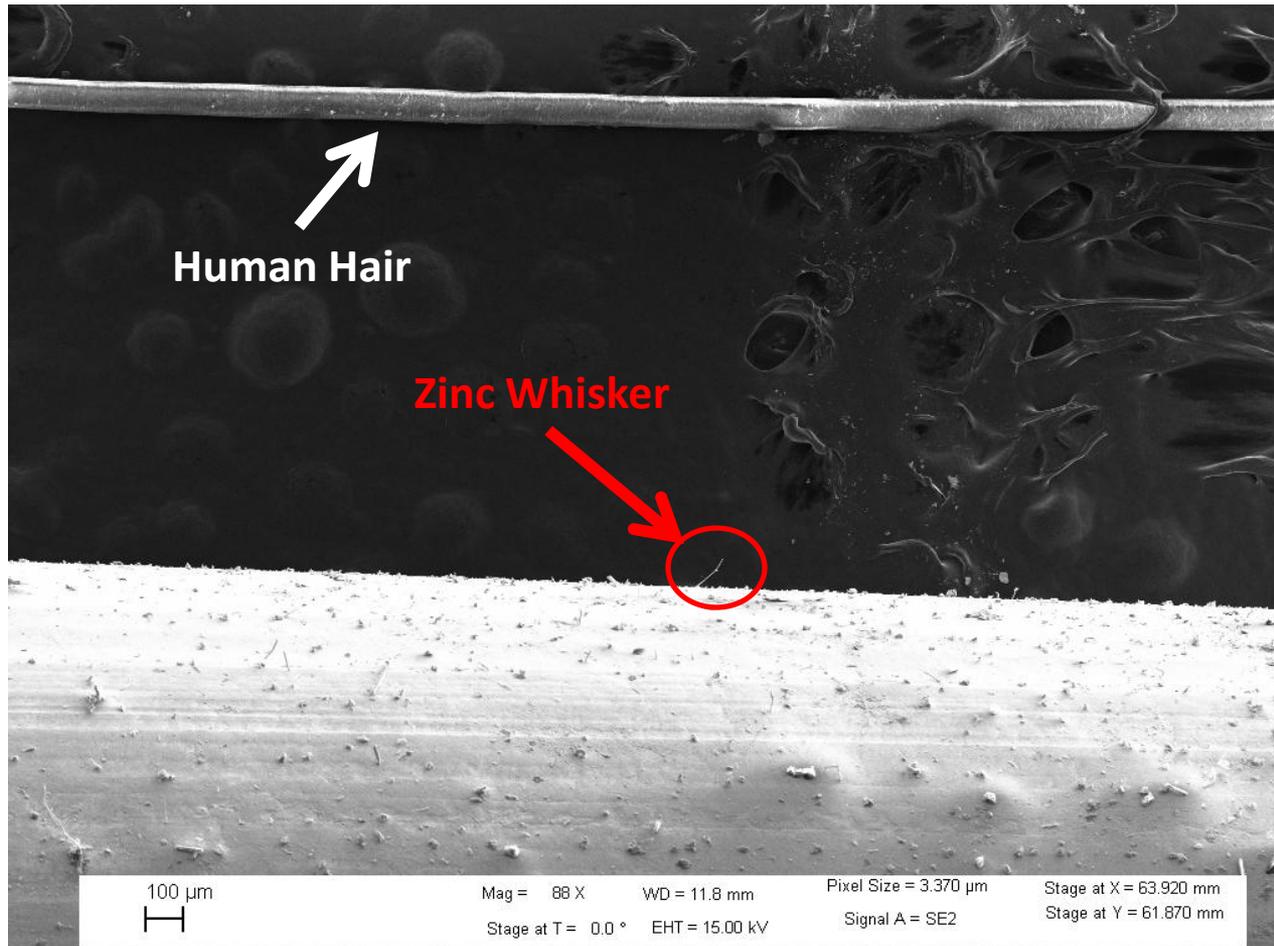
Zinc (Zn) = Pink; Iron (Fe) = Blue



ThinTray-Sample2_02-ZnFe

Some areas of exposed Iron (Fe) are Also present in this Image

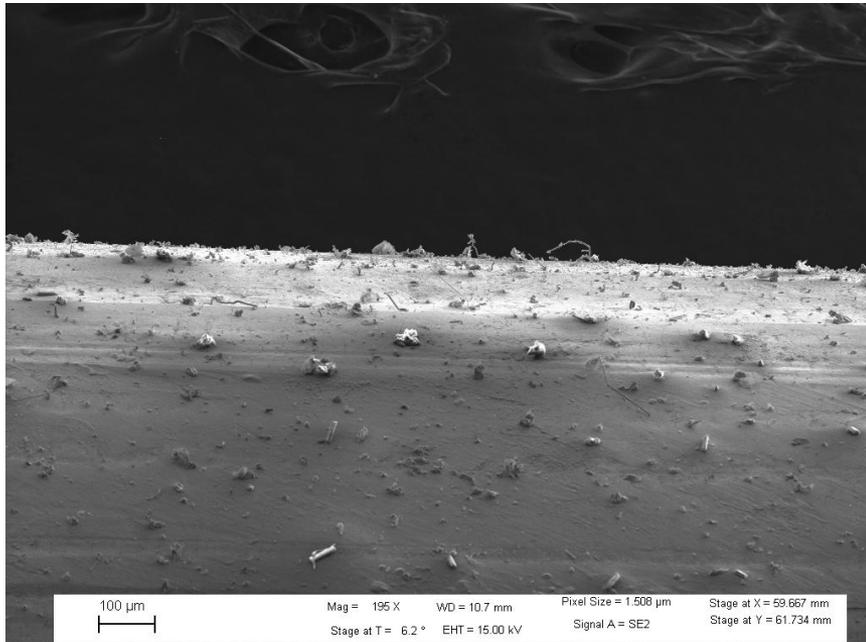
Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*



ThinTray-Sample2_01

November 1, 2012

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*



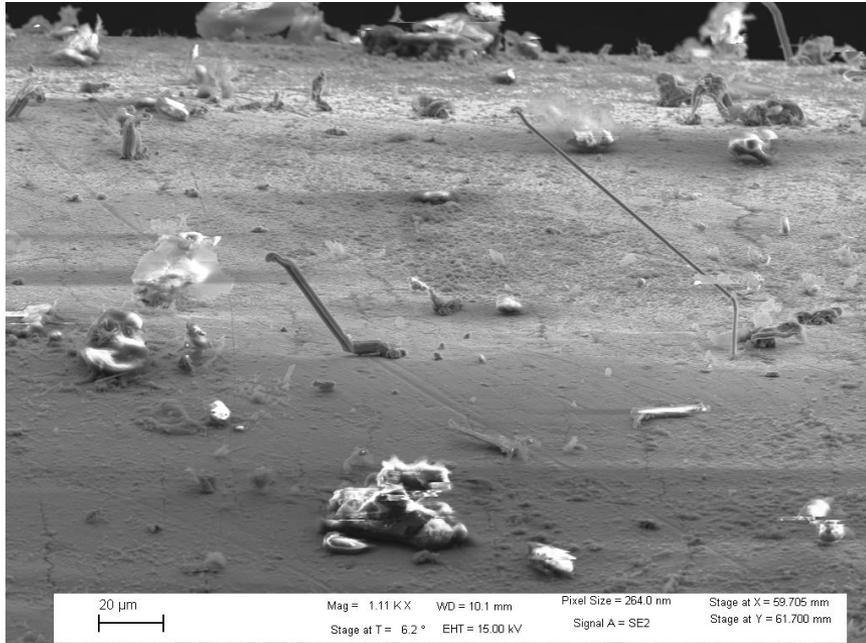
ThinTray-Sample2_04



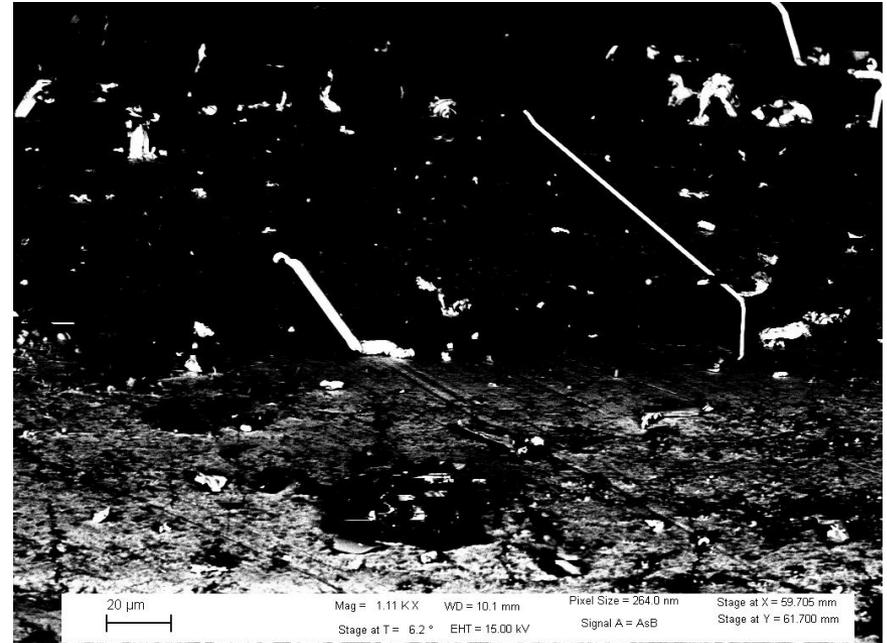
ThinTray-Sample2_05

*Debris on this whisker is not metal, but
dust collected on whisker*

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

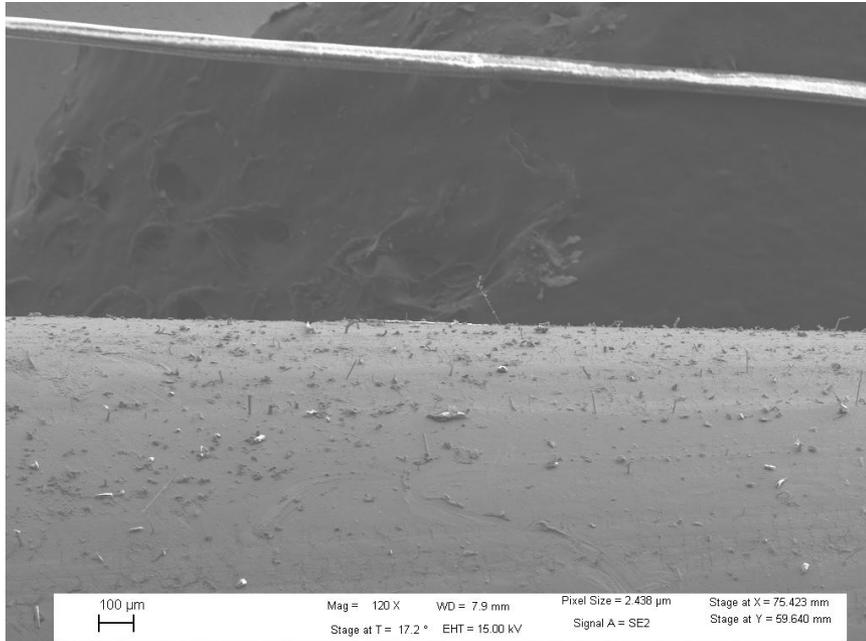


ThinTray-Sample2_06

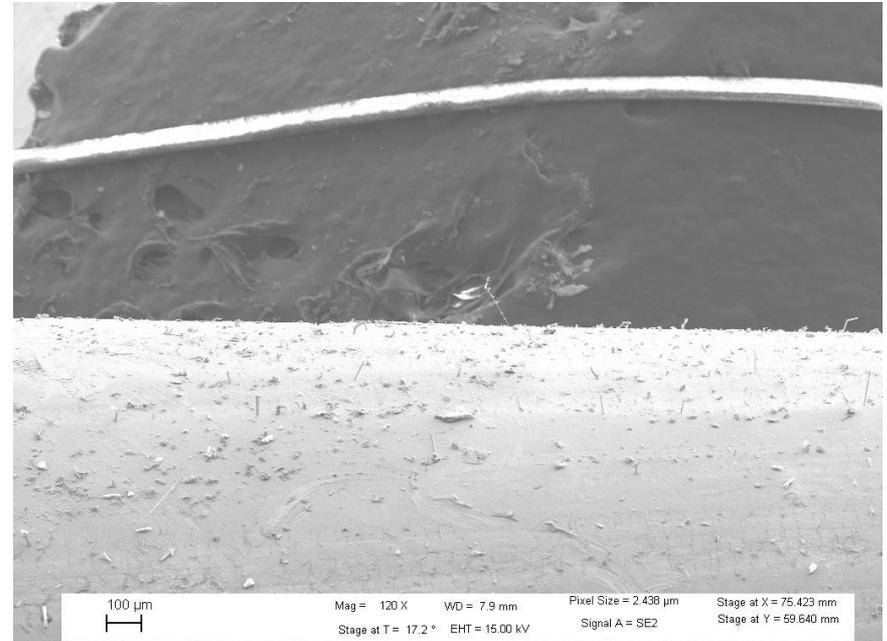


ThinTray-Sample2_07

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

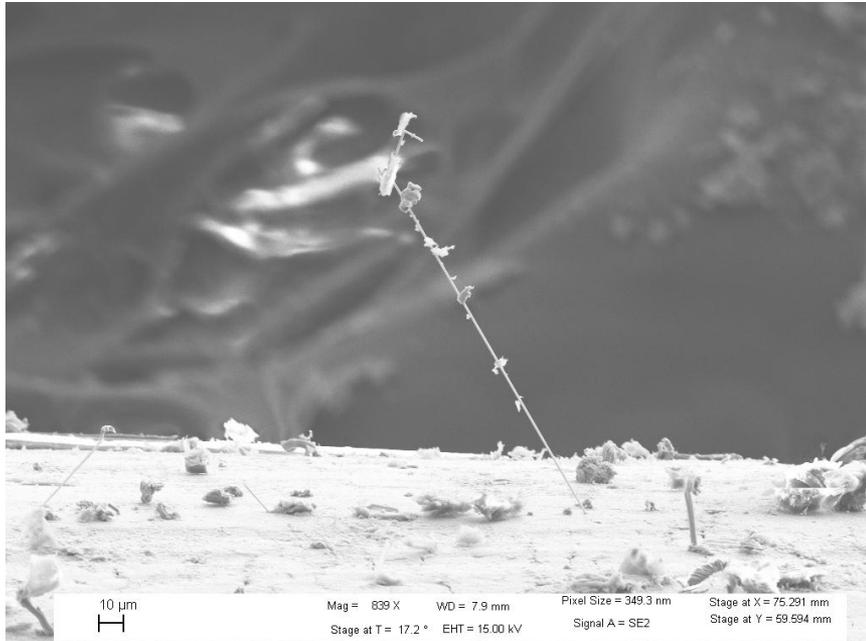


ThinTray-Sample2_10

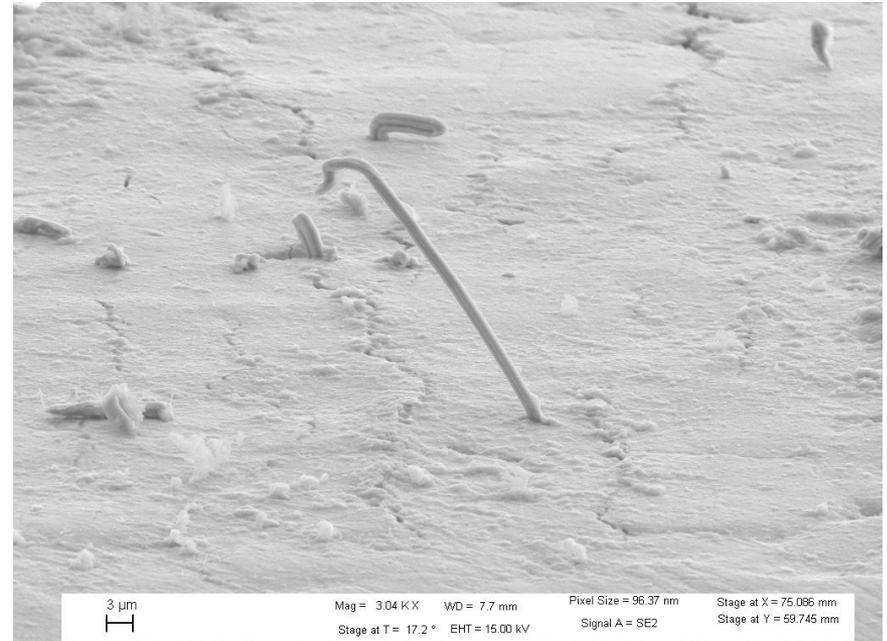


ThinTray-Sample2_11

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*



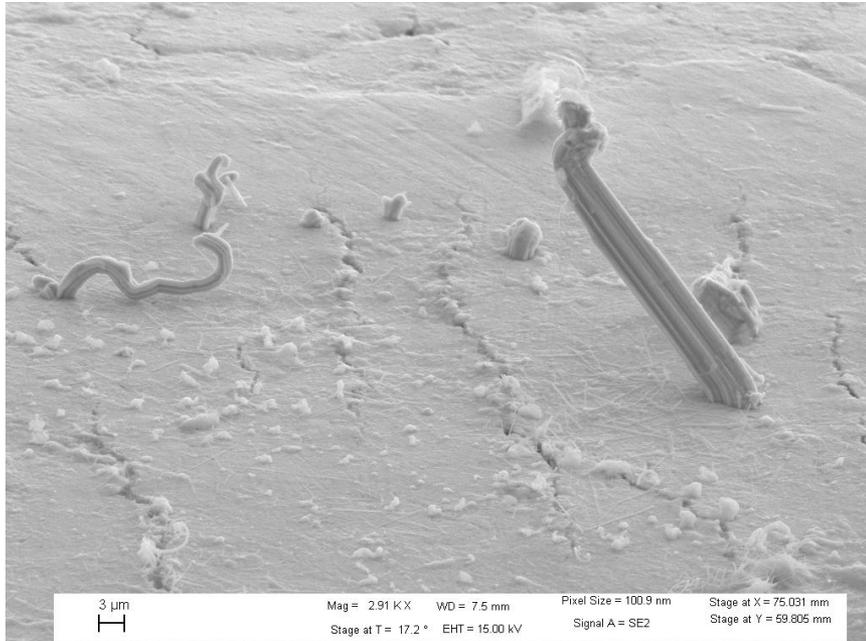
ThinTray-Sample2_12



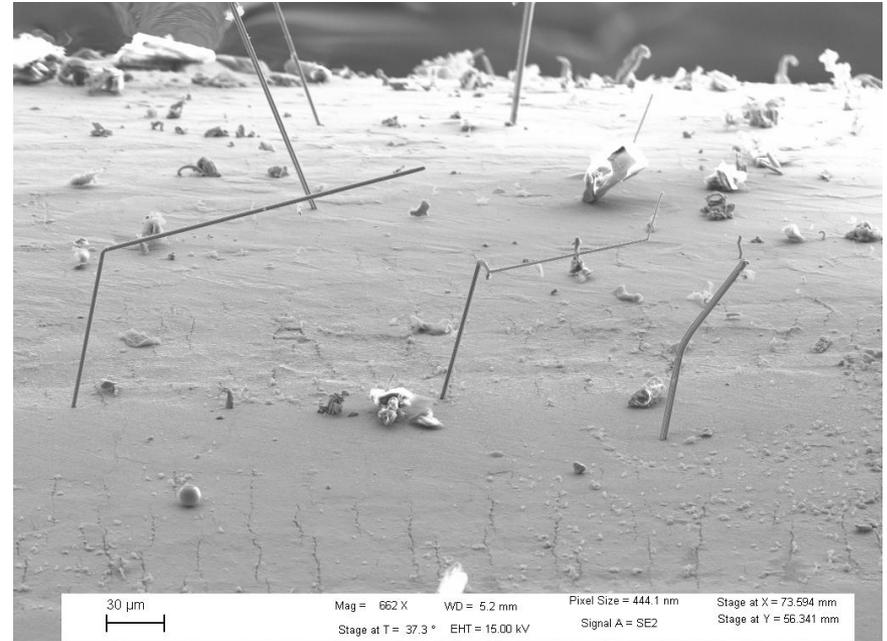
ThinTray-Sample2_13

*Debris on this whisker is not metal, but
dust collected on whisker*

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

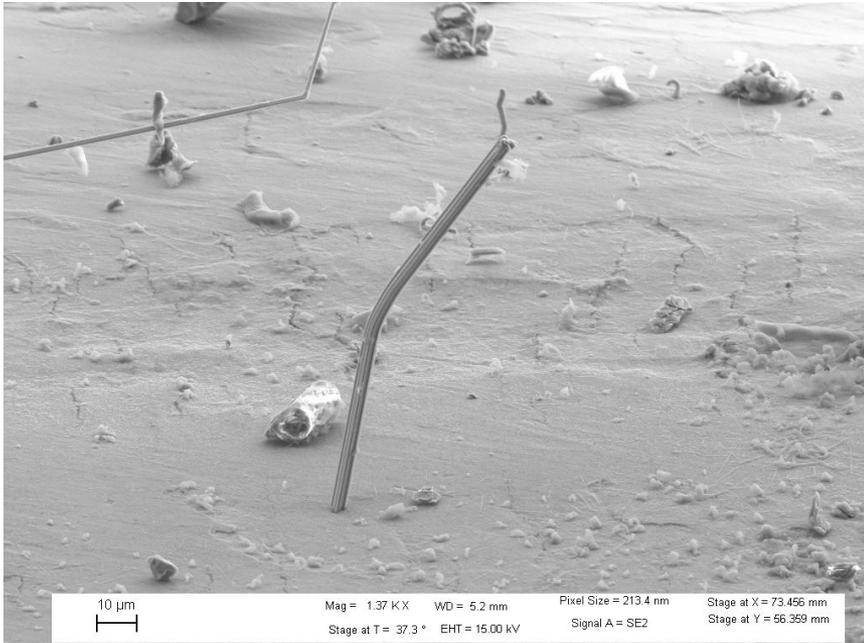


ThinTray-Sample2_14

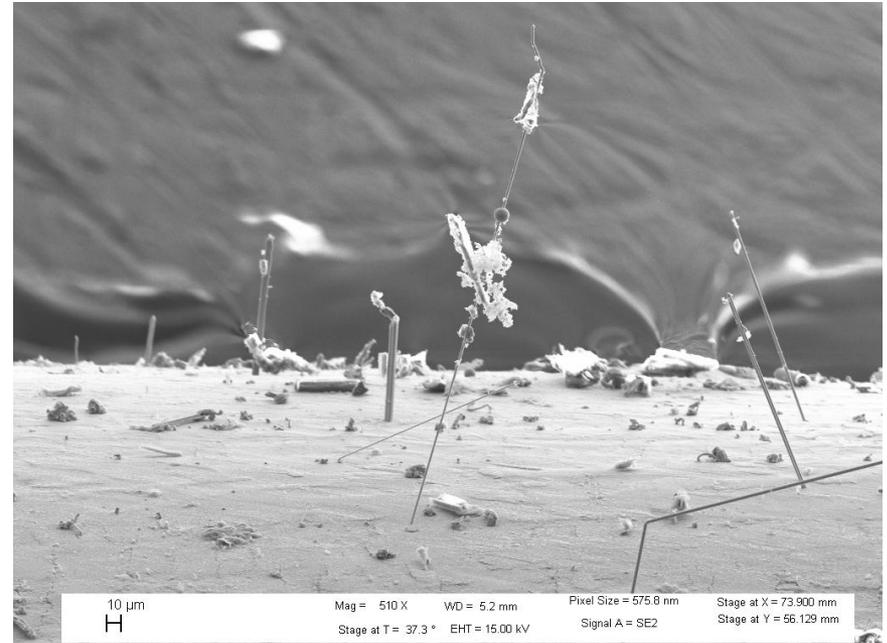


ThinTray-Sample2_17

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

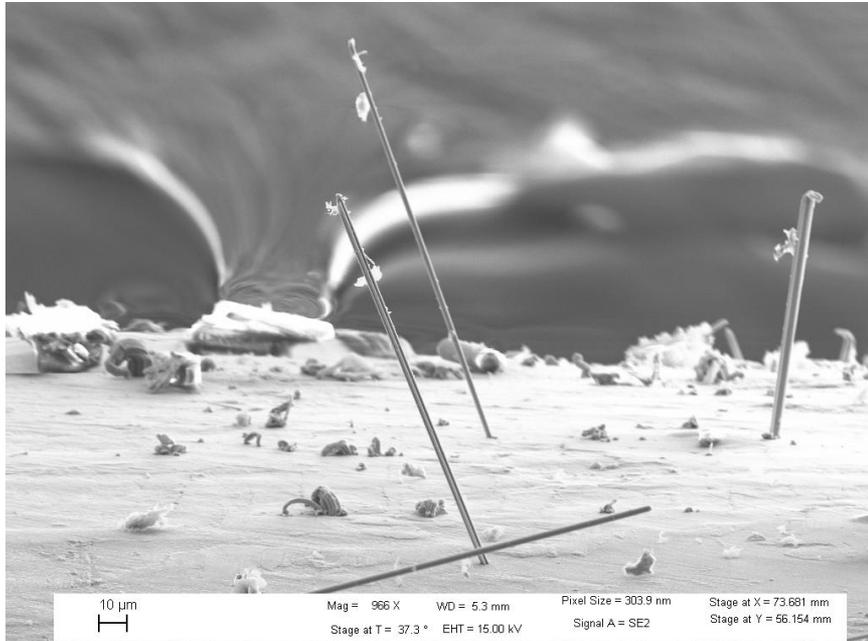


ThinTray-Sample2_18

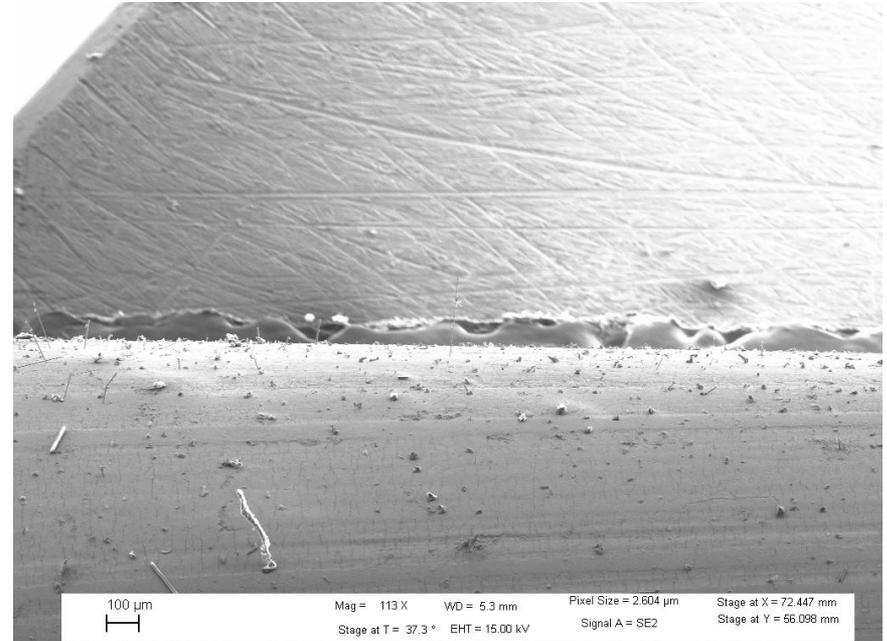


ThinTray-Sample2_19

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

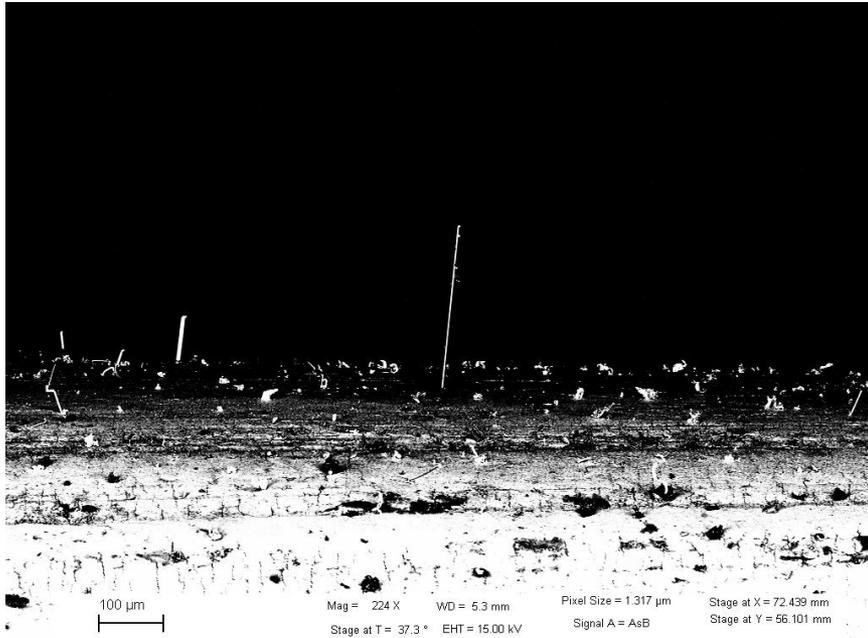


ThinTray-Sample2_20

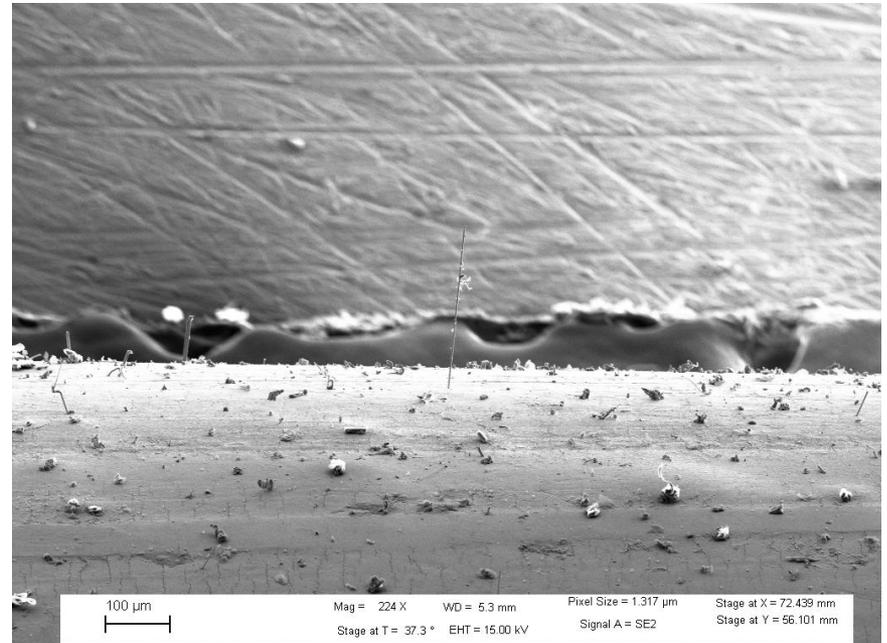


ThinTray-Sample2_21

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

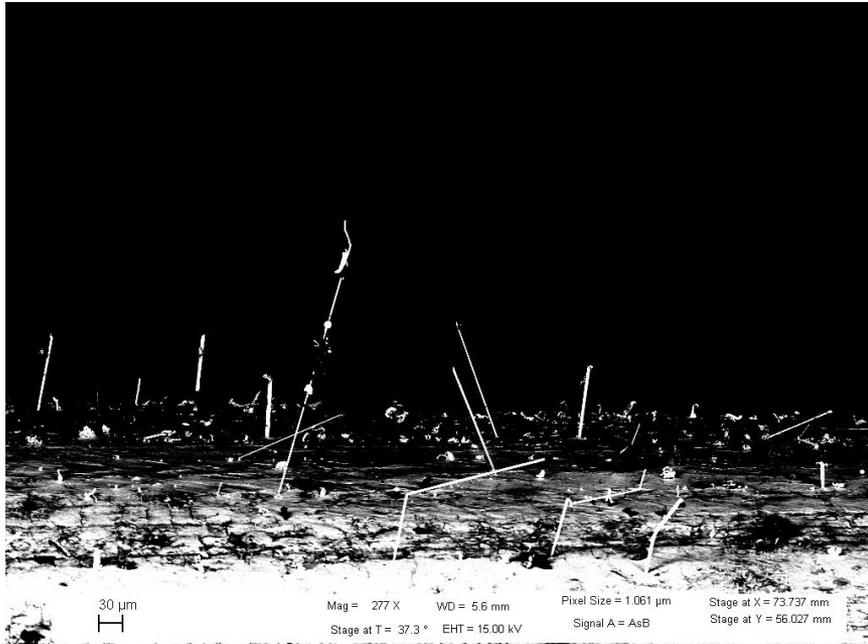


ThinTray-Sample2_23

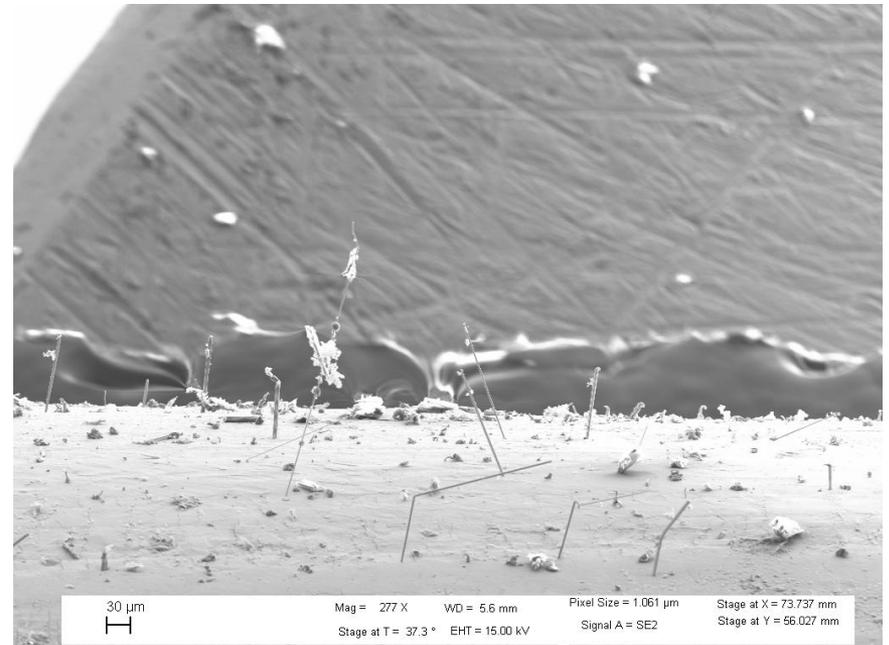


ThinTray-Sample2_22

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

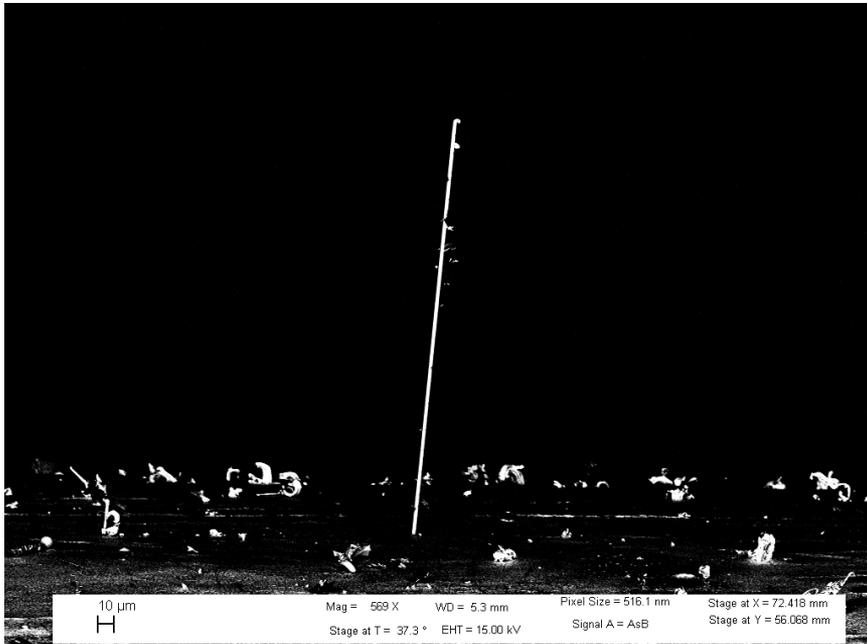


ThinTray-Sample2_16

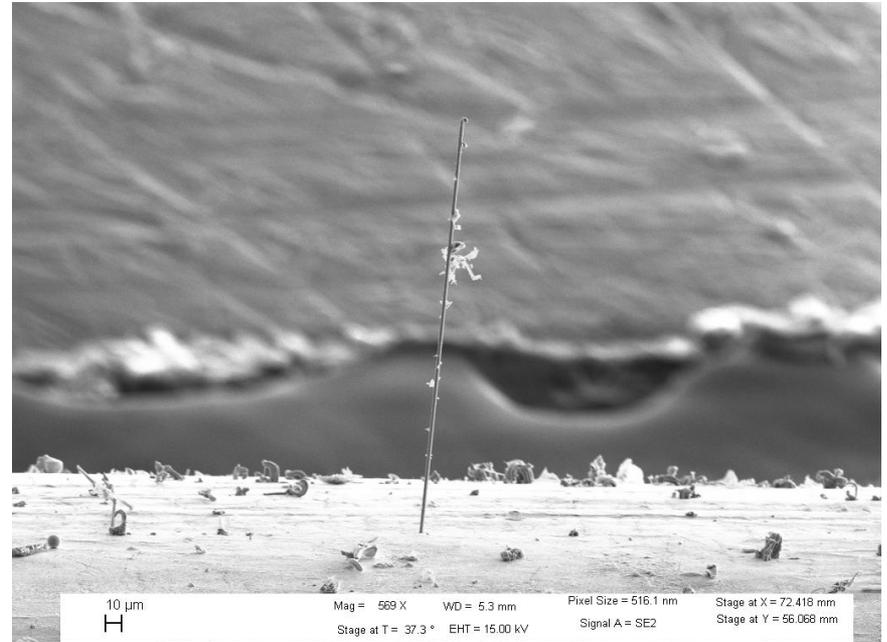


ThinTray-Sample2_15

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

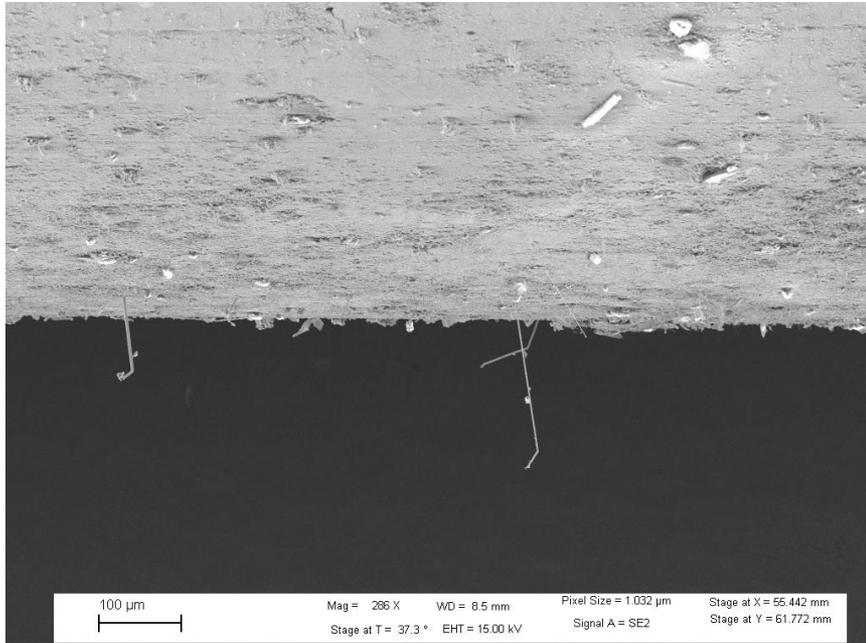


ThinTray-Sample2_25

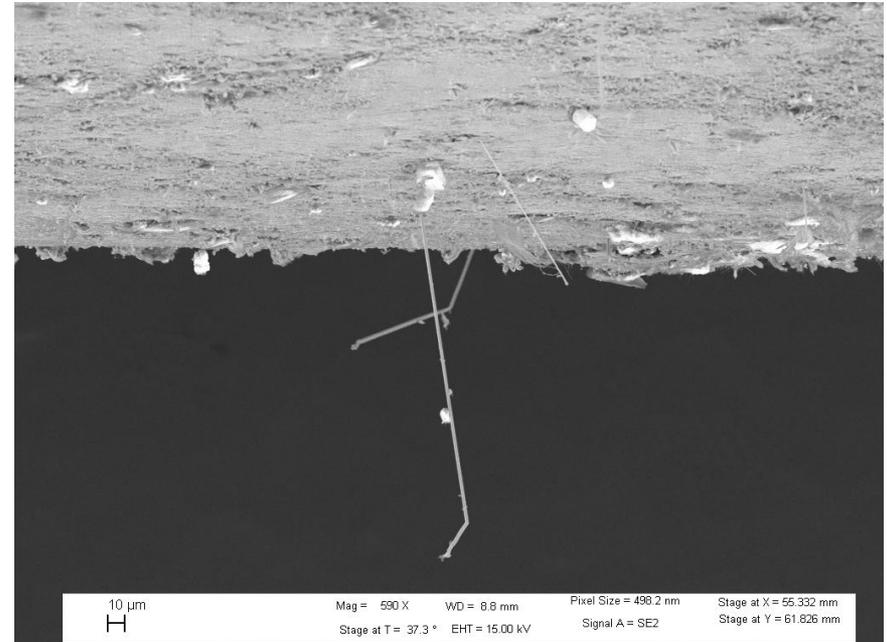


ThinTray-Sample2_24

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*

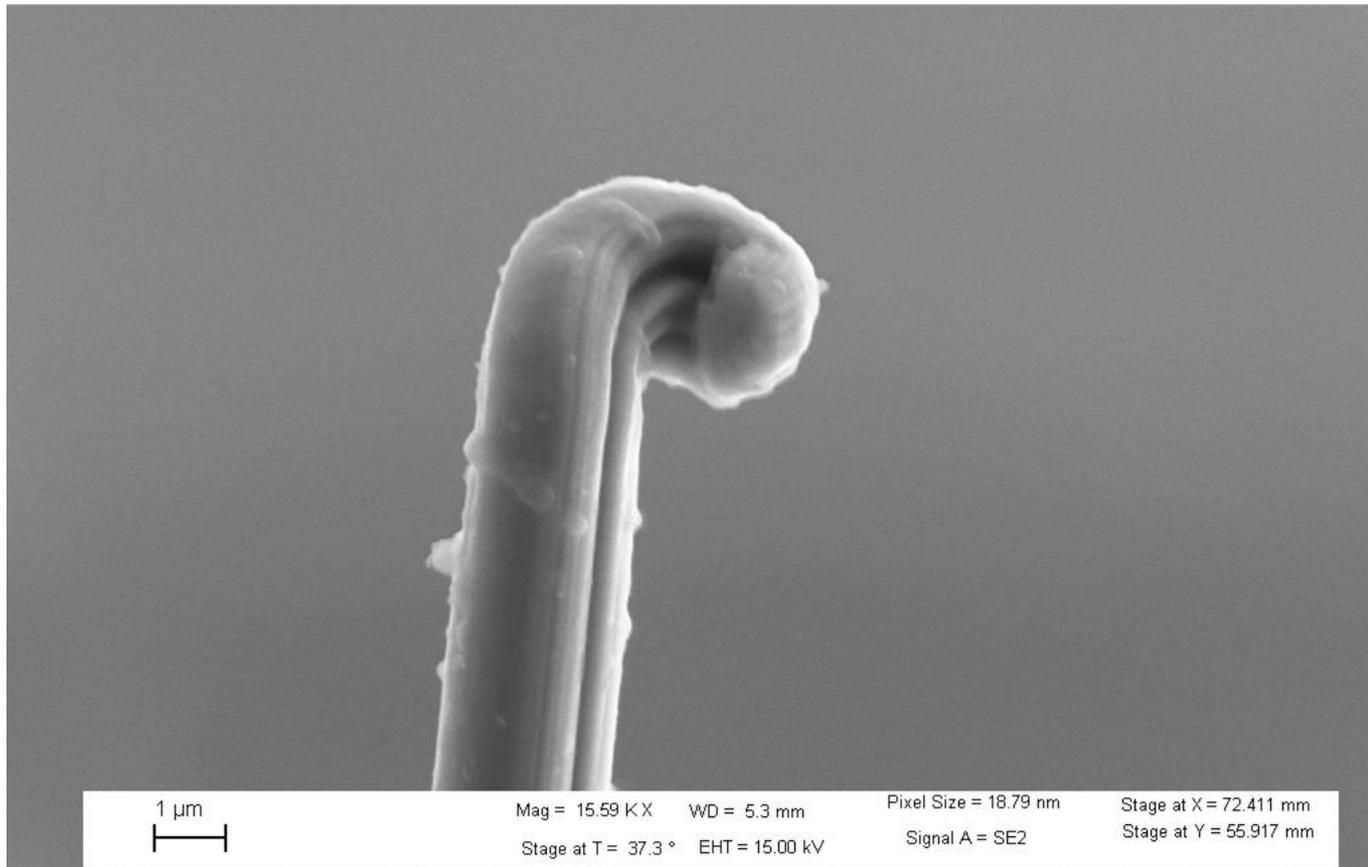


ThinTray-Sample2_28



ThinTray-Sample2_29

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #2*



ThinTray-Sample2_26

Contact Information

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